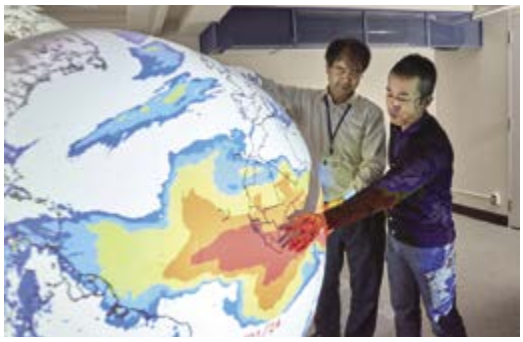
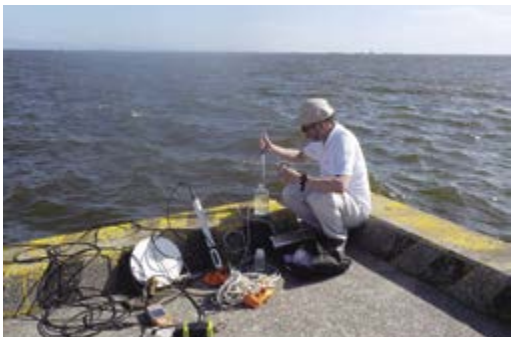




National Institute for Environmental Studies (NIES)

Regional Environment Conservation Division

Director's Greeting

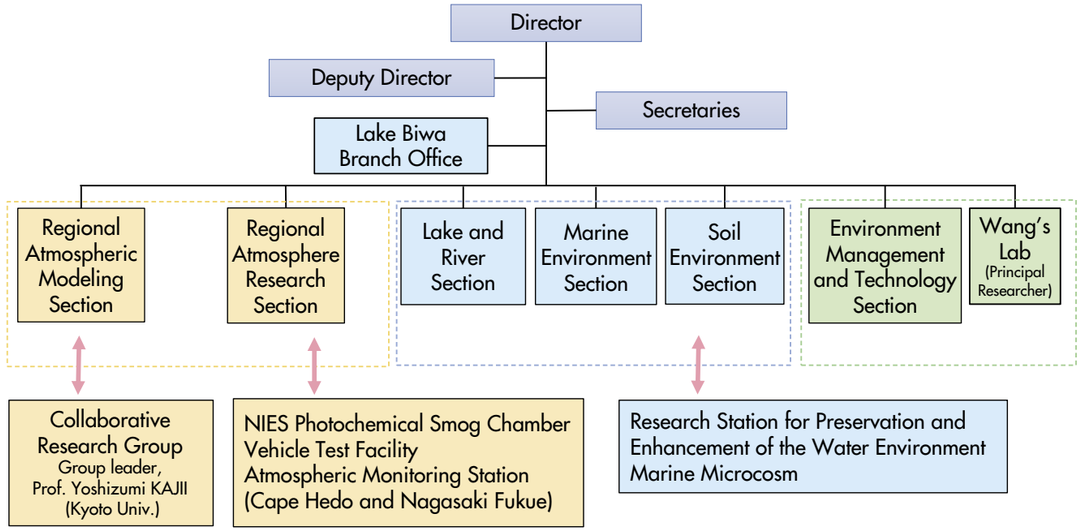
The Regional Environment Conservation Division has a history of conducting research on issues such as air, water, and soil pollution. The atmosphere, water, and soil are indispensable foundations for the survival of human beings, other living things, and ecosystems, as well as for the social activities of people, both now and in the future. We study the production, transport, chemical reaction, and loss processes of substances in each medium; conserve air, water, and soil; and conduct surveys, research, and technological development aimed at the sustainable utilization of these resources.

The word "region" comprises various perspectives. It may refer to a spatial or social unit such as a city, a prefecture, a country, or a region in Asia. It may also refer to a field for individual or practical efforts such those practiced at the municipal level. We conduct research on various environmental problems in individual regions not only to solve air, water, and soil pollution problems, but also to realize sustainable communities.

The Regional Environment Conservation Division consists of two laboratories for atmospheric systems, three laboratories for water and soil systems, and two laboratories for environmental technology. It covers a wide range of research fields such as air, rivers and lakes, coastal waters, soil, land areas, and environmental technology. In addition, research from a broader perspective has recently become important in regional environmental research, such as the effects of climate change. In order to deal with complex and wide-ranging problems, we collaborate with various kinds of researchers and stakeholders, and conduct research so that we can propose solutions to create a better environment.

TAKAMI Akinori

Regional Environment Conservation Division: Organization



Regional Environment Conservation Division: Research

Policy needs	Laboratories	Research topics
Improvement of the domestic atmospheric environment (particulate matter (PM), ozone). Measures against regional air pollution (e.g., transboundary pollution)	Regional Atmospheric Modeling Section	Research on the construction and improvement of atmospheric models to improve the accuracy of atmospheric simulations
	Regional Atmosphere Research Section	Research on laboratory experiments and atmospheric observations (including long-term monitoring) to investigate atmospheric chemistry and dynamics
Compliance with new water environmental standards (such as bottom dissolved oxygen (DO) concentration) in lake environments	Lake and River Section	Research on the water environments and ecosystem services in lakes, rivers and watersheds
	Lake Biwa Branch Office	Research on water environments and ecosystem services in Lake Biwa and its basins
Conservation of enclosed sea areas and adaptation to climate change	Marine Environment Section	Research on evaluation, prediction, conservation, and management methods of the water environment and ecosystems in marine areas
Remediation technology for heavy metals in soil and mitigation of nitrogen saturation	Soil Environment Section	Research on conservation and preservation of biogeochemical cycles in the soil environment, elucidation of the dynamics of harmful substances, and technological development for improving the soil environment
Development and implementation of technology to maintain and restore a healthy water cycle	Environment Management and Technology Section	Development and evaluation of water environment conservation technologies, support for implementation of appropriate technology in developing countries, and research and study of water infrastructure based on inventory development
Sustainable use of water resources in arid and semi-arid areas	Principal Researcher	Research on vulnerability assessment in semi-arid areas such as Mongolia

Issue-Oriented Research Program

Research Program for Co-design Approach to Develop Environmental Solutions Toward Local Sustainability (Co-design Approach for Local Sustainable Research Program) In the Fifth Five-Year Mid- and Long-Term Plan (2021-2025)

In collaboration with local communities, we study acceptable and effective measures and investigate methods for implementing measures to solve environmental problems and regional issues based on knowledge gained from the humanities, social sciences, and natural sciences.

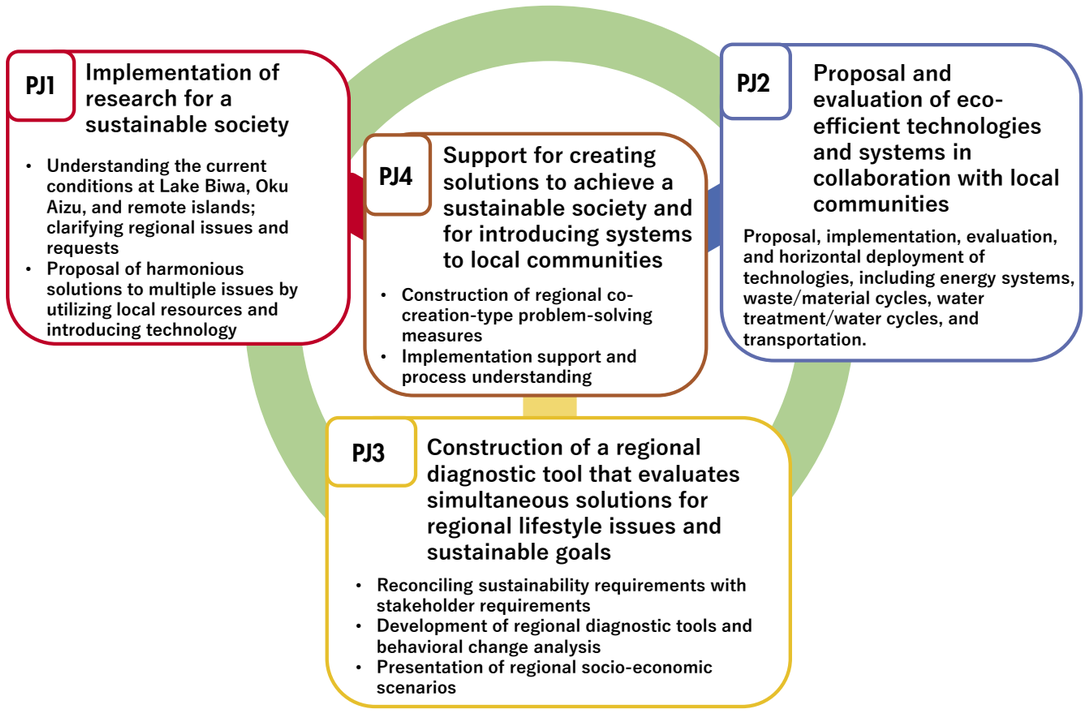
PJ1: Implementation of research for a sustainable society in collaboration with local communities

PJ2: Proposal and evaluation of eco-efficient technologies and systems in collaboration with local communities

PJ3: Construction of a regional diagnostic tool that evaluates simultaneous solutions for regional lifestyle issues and sustainable goals

PJ4: Support for creating solutions to achieve a sustainable society and for introducing systems to local communities

Co-design Approach for a Local Sustainable Research Program



Issue-Oriented Research Program

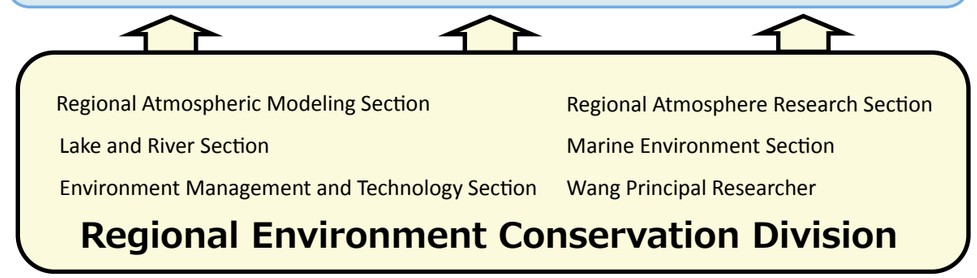
Research Program on Climate Change Impacts, Prediction, and Adaptation, for Atmosphere and Water Environment (Climate Change Adaptation Research Program)

Under the Climate Change Adaptation Act enacted in December 2018, the National Institute for Environmental Studies (NIES) plays a role as the center for collecting, organizing, analyzing, and providing information on climate change impacts and adaptation, and advising local governments and other organizations. The Regional Environment Conservation Division promotes research to contribute to climate change adaptation.

PJ1: Research on Evaluation and Clarification of Effects and Mechanisms of Climate Change

PJ2: Research on Advancement of Climate Change Impact Assessment Methodology

PJ3: Research to Enhance Adaptation Strategies and Practices Based on Scientific Projections

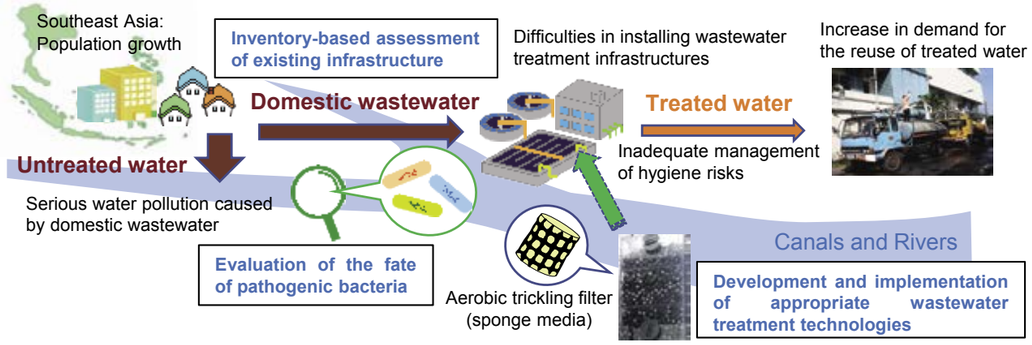


Proposal Research Type-A in NIES

This research aims to strengthen academic research capabilities by using interdisciplinary collaborations and fusions inside and outside NIES to address a wide range of environmental issues.

Evaluation of the fate of pathogenic bacteria with a view to reducing hygiene risk, and development and implementation of appropriate wastewater treatment technology

We evaluate the relationship between the fate of wastewater pathogenic bacteria and water-quality parameters such as nitrogen levels. To manage and reduce hygiene risks caused by water pollution, we investigate appropriate water-quality standards and develop wastewater treatment/water use technologies with the goal of promoting their social implementation in water-quality and water-cycle management in developing countries (SDG 6.3).



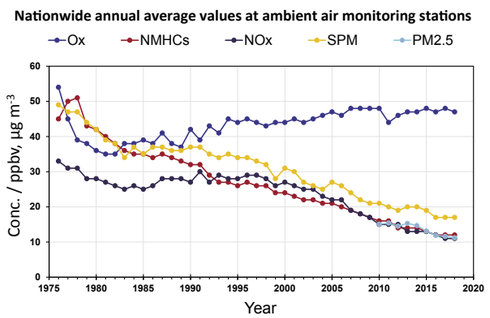
Objective 1: Develop pathogen detection methods and investigate the fate of pathogens in the water environment to set water-quality standards
Development of analytical methods of pathogenic bacteria, evaluation of effectiveness of sanitary indicators, and proposal of appropriate water-quality standards

Objective 2: Development of wastewater treatment technologies for water-quality improvement and safe reuse
Mechanism analysis of the fate of pathogenic bacteria, optimization of wastewater treatment, and proposal of water-quality conservation technology options

Objective 3: Inventory-based assessment of water treatment infrastructures and support for appropriate wastewater treatment implementation
Problem identification in wastewater infrastructure, evaluation of effects of newly introduced technologies, and technical certification of appropriate wastewater treatment technologies in developing countries

A study of multiphase chemistry of hydrogen oxide radicals relevant to tropospheric ozone formation

Despite continuous domestic reductions in the emission of volatile organic compounds (VOCs) and nitrogen oxides (NOx), ground level ozone concentrations continue to remain high. It is hypothesized that the reason for this is that the effect of multiphase reactions of hydrogen oxide (HOx) radicals on ozone formation has not been taken into account. We have constructed a multiphase reaction submodel based on the results of chamber experiments and liquid phase reaction experiments. We are evaluating the effects of future emission controls on ozone concentration by incorporating the multiphase reaction submodel into the atmospheric model. We also are evaluating the effects of future emission controls on ozone concentrations and providing useful information for achieving the environmental standard for oxidants in Japan.



Sub-theme 1: Chamber Experiment Group
- **Determination of uptake coefficients of HOx radicals related to ozone production**

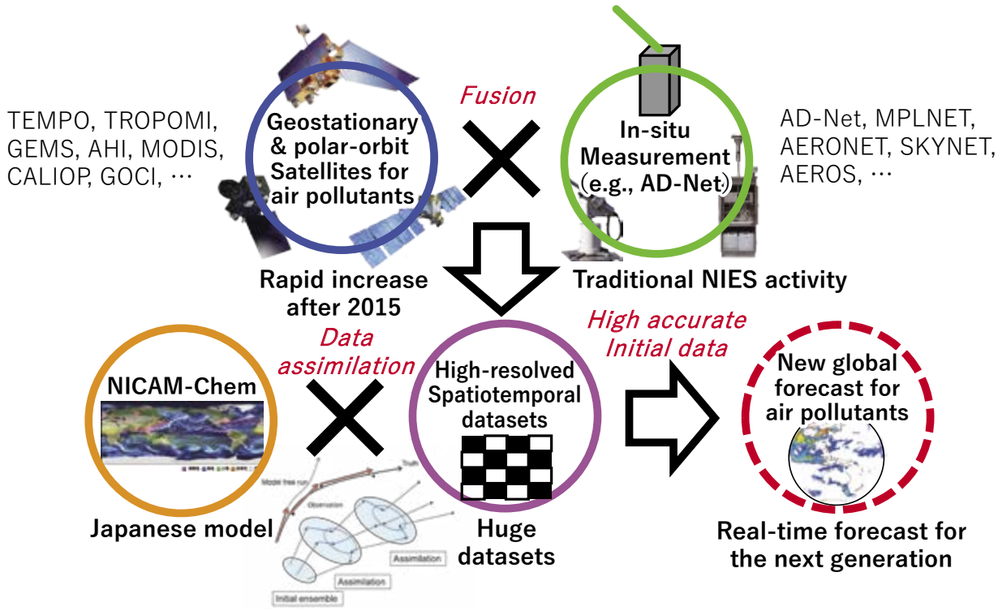
Sub-theme 2: Liquid-phase and Interface Reaction Experiment Group
- **Elucidation of the reaction mechanism that proceeds in aerosols** after the uptake of HOx radicals

Sub-theme 3: Atmospheric Modeling Group
- Introduction of multiphase reactions into the model based on experimental results
- Evaluation of reproducibility of past domestic ozone concentrations
- **Evaluation of the effects of future emission controls on oxidant concentrations** and ozone formation regimes

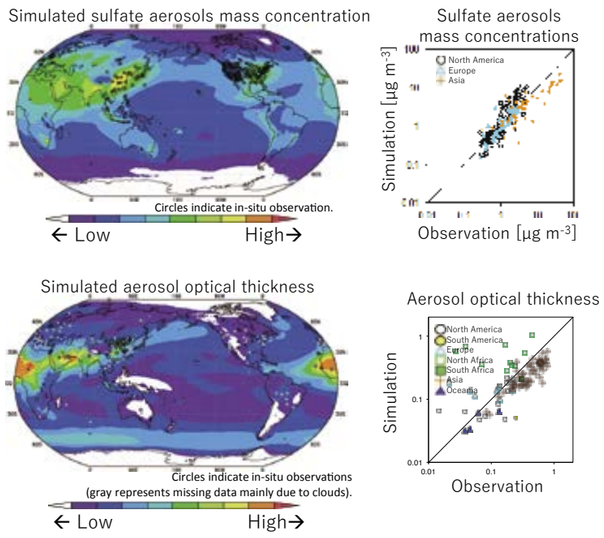
Improvement of ozone prediction models and provision of useful information for achieving environmental standards for oxidants

Development of a methodology to forecast global air pollution by assimilating high-resolution spatiotemporal measurements

This project aims to develop a forecast methodology for global air pollution by using the next-generation model, NICAM-Chem. For this purpose, we have two objectives: (1) to use highly accurate results obtained by an assimilation as an initial condition for the forecast by NICAM-Chem, and (2) to use high-resolution spatiotemporal measurements as assimilated data by fusing various measurements, including those from global geostationary satellites and in-situ/satellite lidars. Achieving these objectives will lead to meeting the goal of improving air pollution forecasts.



Comparison of the aerosols simulated by a global high-resolution model with 14-km grid sizes with observations



These results were obtained by NICAM-Chem, an atmospheric pollution model based on a nonhydrostatic icosahedral atmospheric transport model, NICAM.

These panels were the NICAM-Chem simulated aerosol concentrations, which was the first attempt in the world at conducting long-term integration (3 years) with high-resolution global 14-km grid sizes. High aerosol concentrations were found in urban areas, deserts, and strong-wind regions over the ocean.

Global observations were collected to validate the performance of NICAM-Chem. A comparison between the aerosol concentrations from the model and observations generally shows good model performance, but there were some biases, which should be corrected by improving NICAM-Chem.

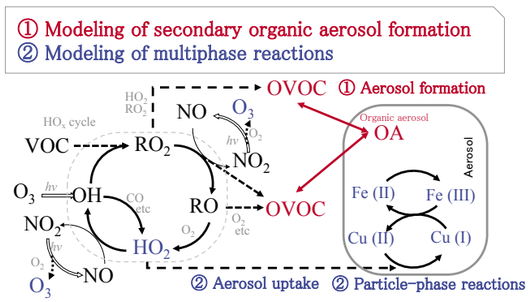
Regional Atmospheric Modeling Section

Our research focuses on air quality modeling to elucidate and predict multi-scale air pollution on urban to Asian to hemispheric scales.

Development and improvement of simulation models and air pollution forecast systems

Model development

We are improving numerical models of chemical reactions for $PM_{2.5}$ and O_3 production. We focus on the role of organic compounds in aerosol formation, and that of radicals and transition metals in multiphase reactions for O_3 formation, in collaboration with laboratory-experiment and atmospheric-observation groups.



Development of VENUS

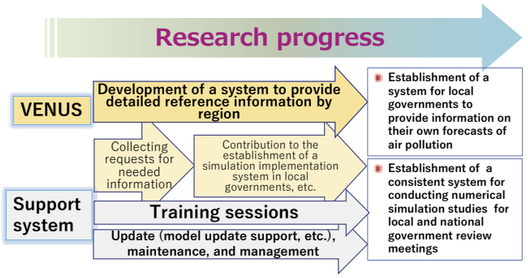
Commissioned by the Ministry of the Environment, we are working on improving VENUS (Visualatmospheric ENvironment Utility System), an air pollution forecast system, in collaboration with the Environmental Information Department and other organizations within our institute. Every morning, the system calculates the concentrations of $PM_{2.5}$ and photochemical oxidants in Japan for the next few days.

Collaborative research with local governmental environmental research institutes on air pollution

We have been conducting collaborative research on air pollution problems such as photochemical oxidants and $PM_{2.5}$ with about 50 local governmental environmental research institutes nationwide. In order to understand regional and meteorological air pollution factors, we are currently divided into several research groups to analyze data obtained from continuous air quality monitoring and to conduct observations.

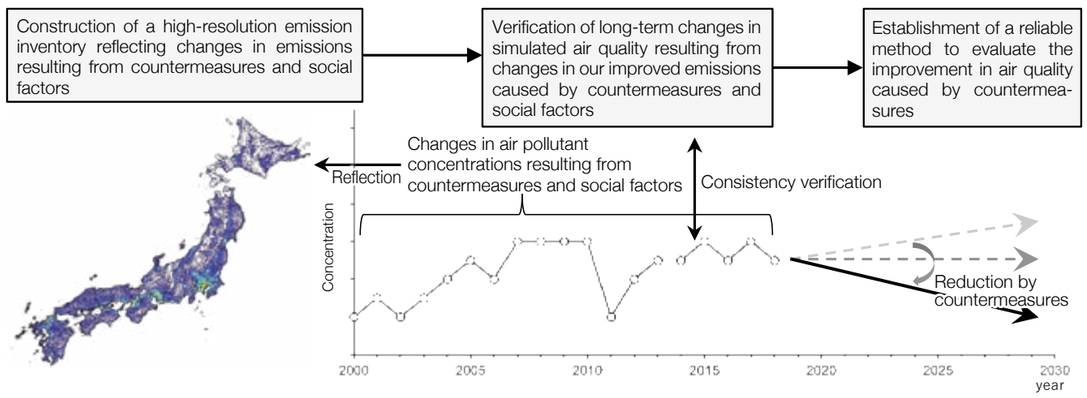
Development and maintenance of systems to support air pollution forecasts in local areas by using simulations (Policy Response Research)

Based on the results calculated by the VENUS air pollution forecast system, we provide valuable information for local governments to make decisions when they issue warnings about photochemical oxidants and $PM_{2.5}$. We also develop and maintain an air pollution simulation support system that can be used for numerical analyses by the national and local governments, and provide user support for the system.



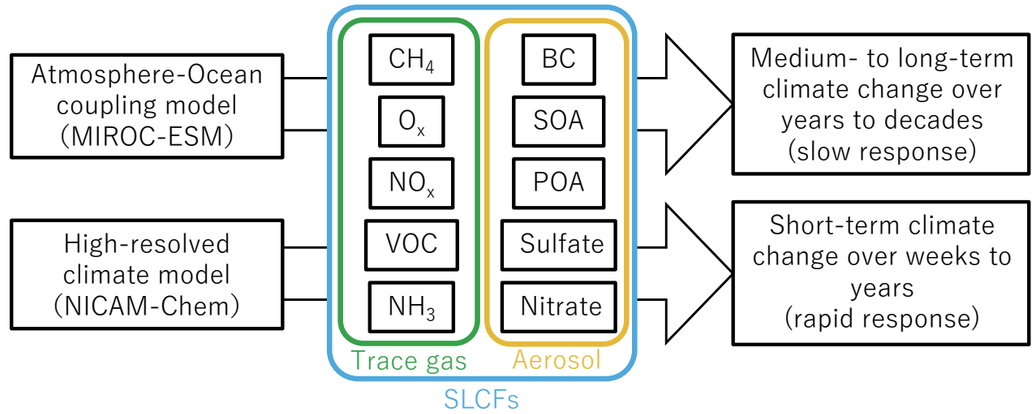
Development of emission inventories and evaluation of effects of countermeasures to improve air quality

An emission inventory is essential input data for air quality simulations, because it collects information on where and how much of the substances that cause air pollution are emitted. We are currently constructing an emission inventory that can estimate the emissions of causative substances for all sources in Japan; it will also show how these emissions change in the past, present, and future as a result of countermeasures and social factors. We are also trying to improve the reliability of predicting the effects of future countermeasures by quantifying the effects of air quality improvements through air quality simulations that employ this emission inventory and showing that it is possible to reproduce past changes in actual air quality.



Research to address climate change and its environmental impact

We are focusing on short-lived climate forcers (SLCFs), which are important in improving air quality and mitigating climate change in the future, in collaboration with the Environmental Research and Technology Development Fund (ERTDF) (S-20-1 in 2021–2025) under the Ministry of the Environment. In the project, we utilize two global-scale numerical models (MIROC-ESM and NICAM-Chem) that can calculate SLCFs to quantitatively evaluate changes in the climate and atmospheric water cycle resulting from changes in anthropogenic emission sources related to SLCFs. Finally, we will perform climate prediction using these models with mitigation scenarios developed by ERTDF (S-20-3).
In addition, we are evaluating the impacts of future climate change on the SLCFs themselves, especially air pollutants, by using a regional-scale air quality model (WRF/CMAQ).

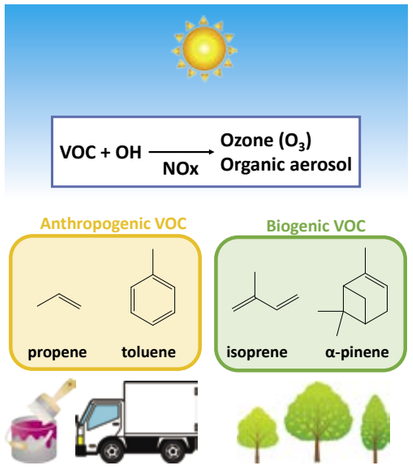


Regional Atmosphere Research Section

We conduct research on urban pollution in Japan and regional transboundary air pollution in Asia by using a variety of methods including ground-level observations, remote-sensing observations, and laboratory experiments.

Study of the formation mechanism of secondary pollutants such as ozone and organic aerosols

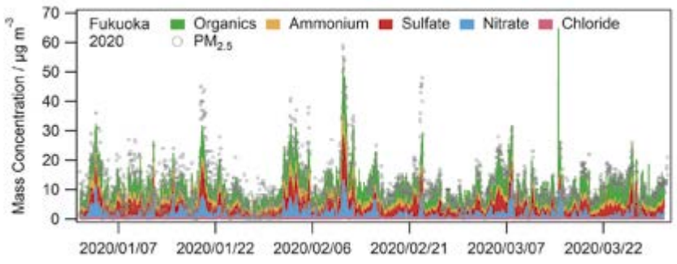
To reduce the concentrations of ozone and $PM_{2.5}$, regulations concerning volatile organic compounds (VOC) and nitrogen oxides (NO_x) have been implemented in Japan and neighboring countries. However, in the East Asian region, ozone concentrations continue to remain high. Using the NIES Photochemical Smog Chamber, we reproduce the atmospheric photo-oxidation reaction of anthropogenic and biogenic VOCs in the laboratory and chemically analyze the gaseous and particulate products produced by the reaction. For more information on the NIES photochemical smog chamber, please see Facilities (P21). By comparing the experimental results with calculations of detailed chemical reaction models by the Regional Atmospheric Modeling Section, we study the reaction mechanisms involved in the formation of pollutants. By studying reaction mechanisms, we hope to provide useful information for reducing pollutants. Furthermore, we are evaluating the performance of a newly developed atmospheric measurement device by using reaction experiments conducted under controlled conditions. Currently, we are evaluating the HOx reactivity measurement instrument developed at Kyoto University and the portable ozone formation regime determination instrument developed at Osaka Prefecture University.



Impact assessment of transboundary air pollution and urban air pollution

Fukuoka City at the time of transboundary air pollutant arrival

To solve the problem of air pollution caused by $PM_{2.5}$ and other pollutants, it is important to clarify the contribution of transboundary and local air pollution. In this laboratory, we are observing the chemical composition of PM in the northern part of the Kyushu area, which is influenced by transboundary air pollution, and estimating where PM is emitted from and through what processes it contributes to air quality. In addition, we are assessing the impact of PM on human health in collaboration with research groups in the Health and Environmental Risk Division and some universities.



Observational results of the chemical composition of particulate matter (PM) in Fukuoka City

Development of a multi-purpose mobility device to address decarbonization, aging, and disasters

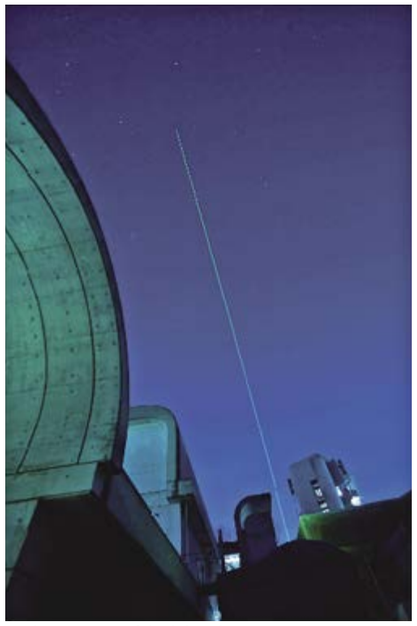
We are conducting research on the development of a multi-purpose mobility device and its widespread use based on the current social system, with the aim of realizing an environment in which passenger car users will voluntarily want to use public transportation. On the other hand, in an aging society such as Japan, it is desirable to provide a means for the elderly and others to move around safely and securely. Furthermore, in the field of nursing care, it is important that both the caregiver and the person receiving care be able to move comfortably and be supported without delay. This mobility system is being researched and developed with the intention of creating a new foundation for social infrastructure, not only for safe, secure, comfortable, and stylish mobility for normal use, but also for evacuation guidance during disasters and for securing means of transportation and communication afterwards.

The ultra-compact personal mobility system can be transformed to suit the user type and the purpose of use (multi-purpose mobility).

Sensing or detecting a dangerous hole or obstacle for the personal mobility user

Development of the automatic stopping system

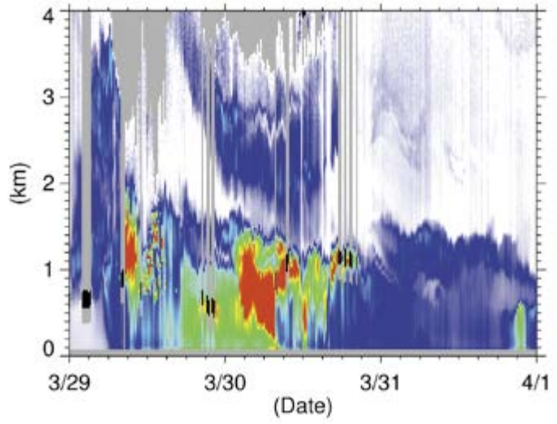
Utilization of the lidar network for observation of Asian dust and anthropogenic particles



Night-time view of the lidar observation station at NIES

Data from the lidar network, which uses laser beams to continuously measure the distribution of Asian dust and anthropogenic particles in the atmosphere, are being used to improve Asian dust prediction models, and to clarify how the generation and transport of Asian dust changes with climate change.

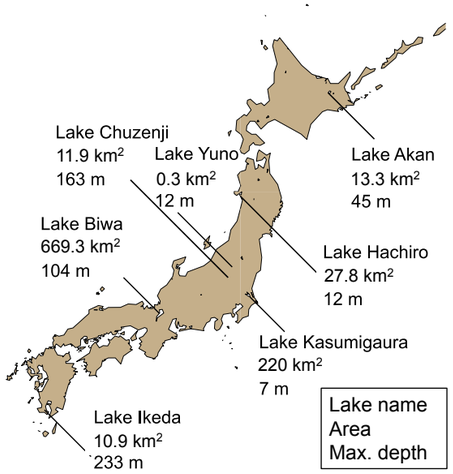
Time–height distribution of Asian dust



The concentration of Asian dust over Matsue (Shimane Prefecture) at the end of March 2021. The yellow-red colored areas correspond to a high concentration.

Lake and River Section

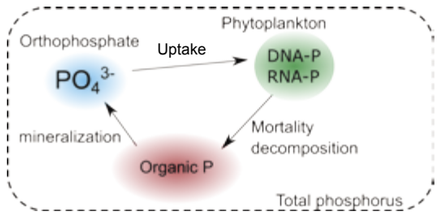
Our laboratory has been monitoring water quality in seven Japanese lakes. In addition, we analyze environmental and water problems caused by high water temperatures and hypoxia. To learn about the factors behind these problems, we are conducting a chronological analysis of long-term monitoring data and exploring methods for water-quality analysis.
We are studying the dynamics of elements such as carbon, nitrogen, and phosphorus in lakes, considering the input and output from basins and production and sedimentation within lakes. Our goal is to create a soundness index for aquatic ecosystems based on ecosystem functions. Another research target is to contribute to mitigation and adaptation strategies under climate change.

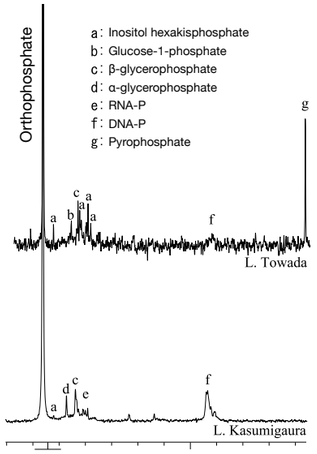


Main research fields in Japan

P dynamics as determined by using ^{31}P NMR spectroscopy

An analytical method was developed to obtain P compound classes by using ^{31}P NMR. We are studying the P compound classes contained in suspended particles and sediments in lakes, which have been a long-lasting “black box”.





An example analyzed by ^{31}P NMR.

The target water body is tracked with a thermal infrared camera mounted to an unmanned aerial vehicle (UAV)

Rapid and accurate monitoring of the spreading dynamics of the target water is important to study its effect on the environment. The developed UAV techniques are suitable for and applied to such monitoring. The upper-right image was taken by a thermal infrared camera mounted to a drone in our laboratory.

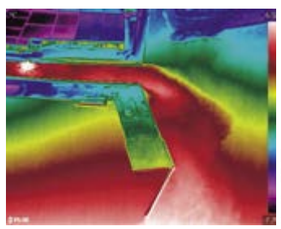


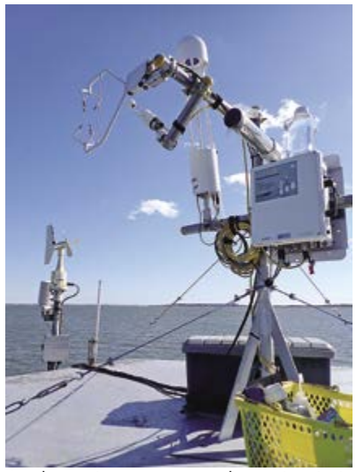

Image of a discharge area of wastewater from a treatment plant. Water temperature shifts from cold to warm in the following order: blue → yellow → red → white.

An analysis of a methane-derived food-web structure by using stable carbon and nitrogen isotope ratios

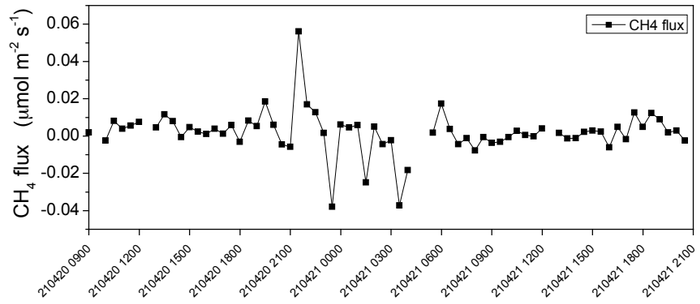
Methane, a greenhouse gas, derived from lake sediment is incorporated into the food web, a process clarified by measuring stable carbon isotope ratios. The function of methane incorporation could decrease methane emissions to the atmosphere.


Organisms of a methane-derived food web

Methane flux measurements obtained by the eddy covariance technique


An observation system at an observation site in Lake Kasumigaura.

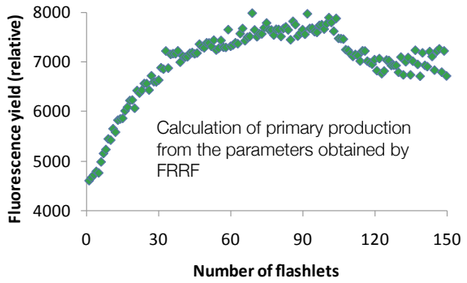
Freshwater lakes are an important source of methane, but more observation is necessary. We have been observing methane emission from the lake surface every 30 minutes by using the eddy covariance technique.



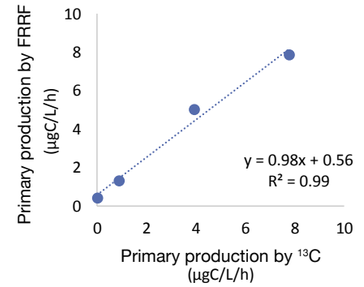
On-site observation of primary production obtained by using fast repetition rate fluorometry (FRRF)

FRRF allows on-site observation of primary production. Primary production has conventionally been measured by using the ^{13}C or ^{14}C methods, but conventional methods could be unavailable for on-site measurements caused by their complex procedures. The procedure used to measure primary production by FRRF is simple. Photosynthesis by phytoplankton is measured at one end of the device and primary production is theoretically calculated. We confirmed that the results by FRRF are comparable with those obtained using the conventional ^{13}C method. Our team has applied FRRF to other lakes in addition to Lake Kasumigaura.


FRRF devices



$$P^*_{O2}(E) = E \cdot \sigma_{PSII} \cdot n_{PSII} \cdot f \cdot qP(E) \cdot \phi_e(E)$$

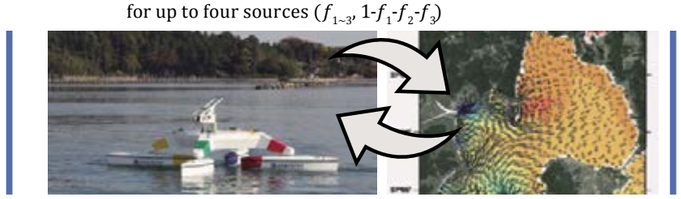


Comparison between FRRF and ^{13}C ⇒The relationship was linear.

Nitrogen-loading analysis by source in a catchment; values are calculated from stable isotope ratios of nitrate in a river

Nitrogen and oxygen stable isotope ratios of river nitrate can be used to estimate the contribution ratio of each nitrogen source in a catchment area by using the four-source isotope mixing model.

A nitrate mixing model using nitrate concentration (N_{1-4}) and its stable isotope ratios ($\delta^{15}N$, $\delta^{18}O$), which can provide the fraction for up to four sources ($f_{1\sim3}$, $1\text{-}f_1\text{-}f_2\text{-}f_3$)



Marine Environment Section

The water quality of enclosed sea areas in Japan has improved since the 1970s, owing to long-standing efforts to reduce the terrestrial load. However, red tides and anoxia still occur in the inner part of the bays, while a decrease in biomass, suspected to be caused by nutrient deficiency, has been reported in adjacent waters. Increases in water temperature and changes in freshwater discharge due to climate change may bring about changes in coastal ecosystems. Therefore, it is necessary to elucidate the mechanisms of environmental impacts and establish a highly accurate method for future prediction to aid in future environmental management. Evaluation of the impact and recovery processes of the coastal environment caused by natural disasters such as the tsunami of the Great East Japan Earthquake, and oil spill accidents, is also an important issue from the perspective of marine environment conservation and disaster mitigation.

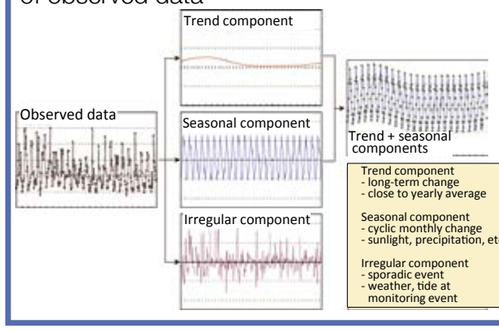
Our laboratory studies issues related to the coastal environment through field surveys, satellite observations, laboratory experiments, and numerical simulations.

Long-term monitoring data analysis

In collaboration with local environmental research institutes, we are collecting monitoring data and satellite data from all over Japan to clarify long-term trends in seawater temperature, seawater quality, benthic fauna, and other factors, and to analyze issues related to water environment management and the effects of climate change in each region.

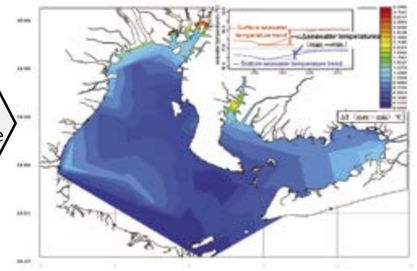
Long-term trend of seawater temperature obtained by data mining (e.g., in *Ise and Mikawa Bays*)

Long-term trend obtained by seasonal adjustment of observed data



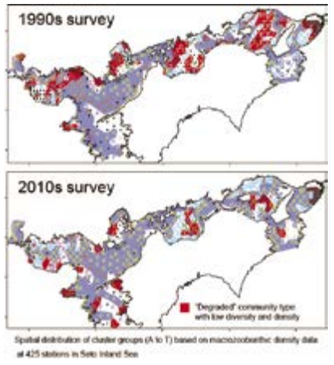
Apply to seawater temperature

Horizontal distribution of 40-years surface seawater temperature increase



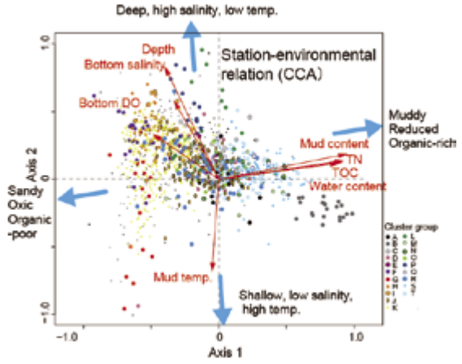
Spatiotemporal changes in macrozoobenthic community structure in Seto Inland Sea

Changes in community structure between 1990s and 2010s



Spatial distribution of cluster groups (A to T) based on macrozoobenthic density data at 425 stations in Seto Inland Sea

CCA analysis: relationships between community structure and environmental parameters



Field surveys and laboratory experiments

We conduct field surveys and laboratory experiments to quantitatively assess the effects of climate change and natural disasters on water quality, sediment characteristics, phytoplankton, and benthic organisms, and to obtain parameters of numerical simulations for future prediction.

Survey of tidal-flat organisms

Survey of the sediment environment

Laboratory experiments using benthic animals

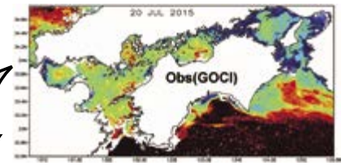
Phytoplankton culture experiments

Numerical modeling and future predictions

We are developing an integrated land–ocean model for predicting the water environment of semi-enclosed seas. This model will be applied to predict climate change impacts and to study nutrient management for adaptation and conservation.

Improvement of the integrated land-ocean model using long-term monitoring data and satellite product

Satellite product (SST, SSS, ocean color, etc.)

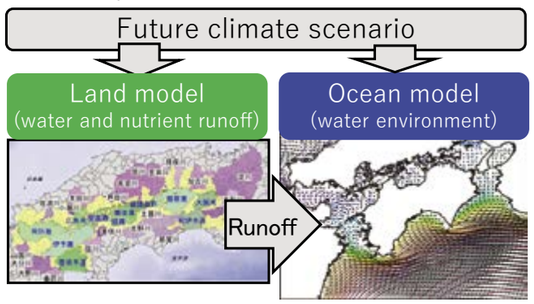


Model improvement and validation

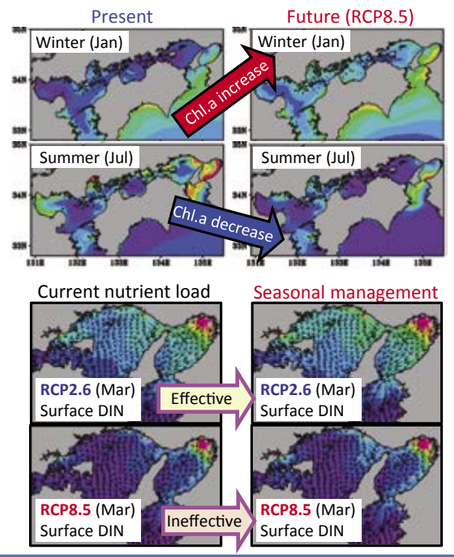
Future climate scenario

Land model (water and nutrient runoff)

Ocean model (water environment)



Prediction of climate change impacts and nutrient management as adaptation for coastal environment

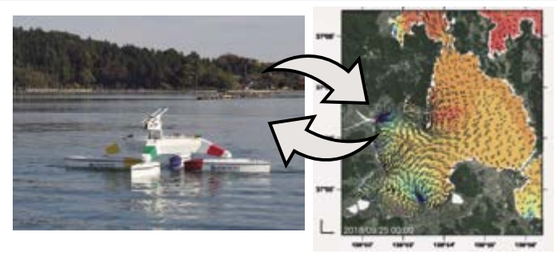


SST: Sea Surface Temperature, SSS: Sea Surface Salinity, GOCI: Geostationary Ocean Color Imager, Chl. a: Chlorophyll-a, DIN: Dissolved Inorganic Nitrogen

Advancement of monitoring methods using ICT technology

To build a support system for monitoring and managing the water environment in coastal areas, we are developing technologies for automatic water-quality observation by using a quadmaran automated vessel (RoboSen). We are also using drones to collect sea color data, the cloud for real-time data processing and visualization, and artificial intelligence for short-term forecasting.

Development of novel water environment monitoring methods using ICT technologies



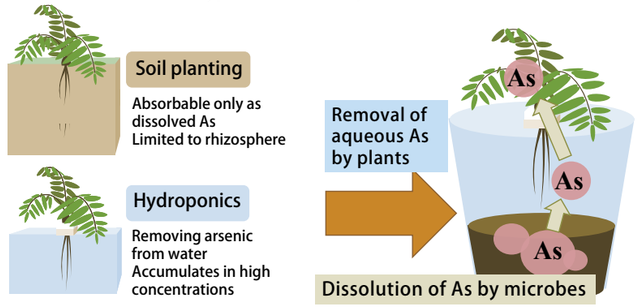
Soil Environment Section

Soils are formed in response to natural conditions such as climate, geology, and human land use. They serve as a cushion to mitigate the effects of anthropogenic pollution and provide a place for biological activities and water-quality control. Our laboratory conducts research on the interaction of the soil environment with water, air, and organisms. We also study material cycles, pollution mechanisms, and the development of remediation technologies.

Development of a soil remediation system using microorganisms and plants

Arsenic-contaminated sites have been found throughout the world, particularly in Japan, where arsenic has become one of the most prevalent soil contaminants. In this project, we are developing a novel remediation technique for arsenic-contaminated soil by using microorganisms and plants. We are also evaluating microbial communities involved in the remediation process through molecular biological analyses.

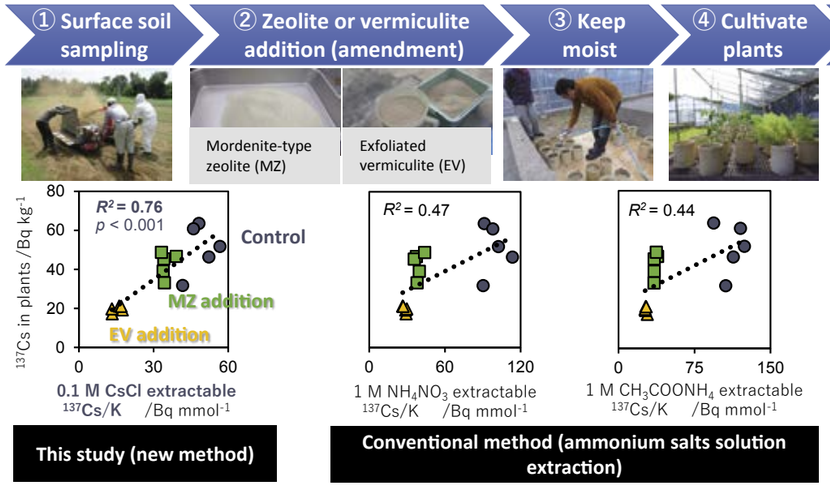
➢ *Pteris vittata*　A hyperaccumulator plant for arsenic (As)



A Novel Soil Remediation System Combining Microorganisms and Plants

Evaluation of a selective extraction method for available radiocesium in soils

To evaluate the mobility and bioavailability of radiocesium (rCs) in soils, we compared the extraction of rCs with that of stable Cs and ammonium solutions from rCs-contaminated soils. Plant-available rCs was assessed by using Kochia (*Bassia scoparia*) cultivated in pots of contaminated soils; soil parameters, including extractable rCs and K, were then compared. The rCs/K ratio extracted with a stable Cs solution was found to be a potential index for evaluating the readily mobile and bioavailable fraction of rCs in soil.



The data in these figure panels indicate that extraction with 0.1 M CsCl could be a good method for predicting the plant uptake of rCs during short-term cultivation.

Mechanisms of material accumulation and disturbance in soil and wetland ecosystems

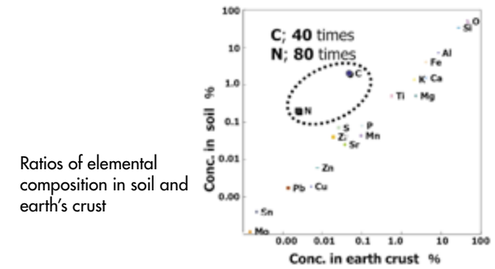
The process of soil formation on the earth's surface can be considered as a process of organic matter accumulation that proceeds through the flourishing of living organisms. The amount of carbon and nitrogen accumulated in the soil through this process is said to be about 40 and 80 times higher, respectively, than the global average concentration of these elements in the earth's crust. We are studying the effects of various disturbances (climate change, human activities, wildlife behavior, volcanic eruptions, etc.) on the accumulation processes of carbon, nitrogen, and phosphorus, which are typical biogenic elements in soil.


Soil survey in the forest

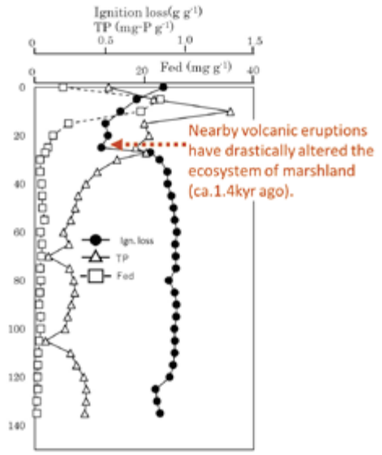

A thick layer of organic matter accumulation (Andisols)


Thick peat layer in the Ozegahara mire


The Ozegahara mire



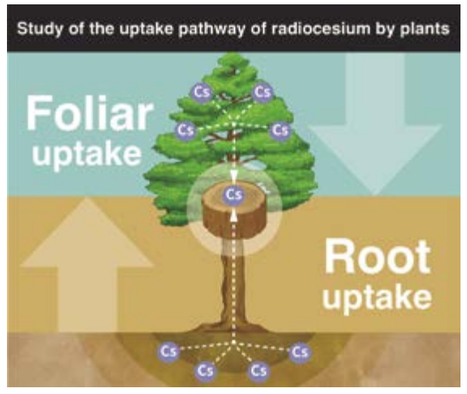
Ratios of elemental composition in soil and earth's crust



Vertical distribution of organic matter, phosphorus and iron in Ozegahara mire

Understanding the fate of radiocesium in forest ecosystems

Forests in Fukushima and the surrounding prefectures were contaminated with radiocesium (rCs) after the Fukushima Daiichi Nuclear Power Plant accident in March 2011. We are investigating the behavior of rCs in forest ecosystems, including the uptake of rCs by plants, the transfer of rCs between plants and soil, and the mobility of rCs in soil. The photographs below show the site where we are investigating why koshiabura, known as the "queen" of edible wild plants, accumulates high levels of rCs and what can be done to reduce those levels.



Environment Management and Technology Section

The Environmental Management and Technology Section conducts research on the development of energy-saving wastewater treatment technologies and supports their implementation. We also assess wastewater treatment infrastructures and the environmental impact of water pollution to preserve water quality in each region.

Measurement of greenhouse gas (GHG) emissions from wastewater and development of an appropriate treatment reactor

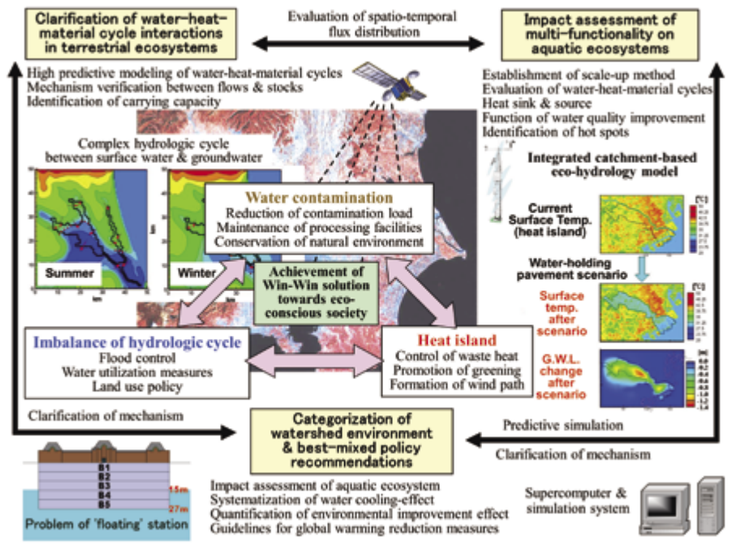
Water quality and GHG emissions were measured to assess the environmental load associated with treated and untreated wastewater. In Malaysia, water quality and GHGs were measured during treatment of palm oil mill effluent in an anaerobic pond. In addition, an appropriate anaerobic treatment reactor has been developed to improve the water environment and reduce GHG emissions.

Survey on water quality and GHG emissions in an anaerobic pond

Laboratory-scale reactor

Development of an integrated catchment-based eco-hydrology model and ecosystem assessment

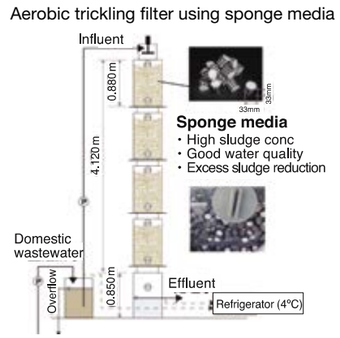
Sustainable development in watersheds requires the assessment and proper management of the water cycle, material cycles, and associated ecosystem functions. In our laboratory, we developed a numerical model for simulations (NICE: National Integrated Catchment-based Eco-hydrology model). We are working on the construction of assessment and support systems for social implementation to comprehensively manage various water-based elements, such as surface water and groundwater, agricultural and industrial uses of water, water quantity, water quality, heat, and appropriate environmental management technologies.

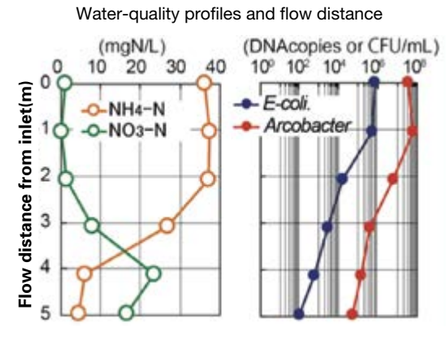


Construction of an integrated assessment system with the goal of creating healthy water-heat-material cycles

Development of appropriate water-quality conservation technologies for social implementation

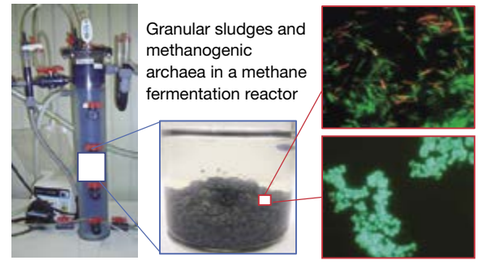
Over 80% of the world's wastewater is discharged untreated into the environment, causing water pollution and sanitation problems. To introduce and maintain wastewater treatment technologies in developing countries and rural areas, it is important to reduce the energy costs associated with water treatment and improve maintainability. In collaboration with the Bangkok Metropolitan Administration in Thailand, we evaluated the performance of a newly developed wastewater treatment technology (an aerobic trickling filter) for decentralized domestic wastewater treatment. This technology showed excellent removal efficiency against organic matter, nitrogen, *Escherichia coli* (*E. coli*, a hygiene indicator), and other pathogenic bacteria. In addition, the technology significantly reduced power consumption and excess sludge. Finally, the technology was successfully introduced as a full-scale (40 m^3) wastewater treatment for company housing in Thailand.





Evaluation of an energy-saving domestic wastewater treatment system (Bangkok, Thailand)

The production of electronic devices has increased significantly in response to demands from modern information technologies. Electronics manufacturing processes discharge wastewater containing high-risk organic chemicals (tetramethylammonium hydroxide and monoethanolamine). Therefore, we are developing energy-saving and energy-creating methane fermentation technologies for electronics industry wastewater. We have investigated appropriate inoculum sources, effective retention methods by biofilm formation, and mechanisms of organic chemical biodegradation. This basic knowledge contributes to improving and stabilizing treatment performance, and will expand the application range of methane fermentation technologies.



Development of a methane fermentation technology for high-risk industrial wastewater treatment

Development of methods for evaluating the effects of installing a wastewater treatment technology (Bangkok, Thailand)

Bangkok's sewage system services approximately half of its residents, which is a high level in Asian developing countries. However, the water quality in some urban canals has not been improved even though the sewage treatment systems are well operated. We analyzed time-series data in a water-quality survey of urban canals and found that NH_4-N concentration is highly correlated with biochemical oxygen demand (BOD) concentration. Furthermore, treated water directly discharged into the canals from high-rise buildings that have installed self-treatment facilities, such as condominiums, may affect water quality in urban canals.

Although a potential solution would be to install energy-saving decentralized treatment technologies that our laboratory is developing, it is important to understand where and how much wastewater and water pollutants could be generated. Therefore, we are developing methods to better understand the wastewater inventory as well.

In addition, we are measuring practical power consumption of an existing sewage treatment plant as a baseline for an evaluation of the effectiveness of introducing new technologies.

Treated wastewater directly discharged from a condominium into an urban canal

Principal Researcher (Wang's Laboratory)

We evaluate the effects of climate change and anthropogenic disturbances on the water cycle and animal husbandry, as well as adaptation strategies for typical grasslands in arid and semi-arid areas.

Climate change impact monitoring and adaptation assessment in grasslands

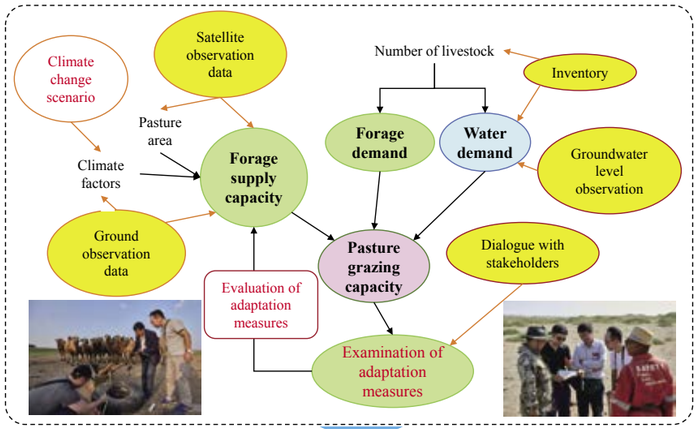
There are concerns about the rapid degradation of grasslands due to the thawing of the permafrost, loss of soil moisture, and drought, caused by climate change. There is an urgent need to investigate adaptation measures and plans.

Monitoring the impact of climate change on pasture grazing capacity

We attempt to monitor and assess the impact of climate change on forage production and water resources. Then, by estimating the forage and water demand, we can clarify the grazing capacity of grasslands based on the difference between supply and demand.

Investigation of adaptation measures and evaluation of their effects

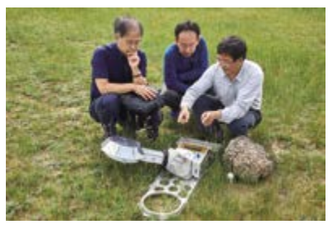
We are refining a model that can evaluate pasture grazing capacity and its vulnerability. The model will be used to evaluate the effect of adaptation measures on grazing capacity, such as increased forage cultivation, expansion of the water supply, and appropriate management of livestock numbers.



Sharing scientific knowledge to stakeholders through Asia-Pacific Climate Change Adaptation Information Platform (AP-PLAT), Future Earth (FE), environmental policy dialog, etc.

Monitoring CO_2 absorption and emission in grasslands and evaluating the reduction effect

To understand and verify the reduction effect of low-carbon systems using the GOSAT products, we monitor CO_2 absorption and emission in pasture areas of Mongolia.

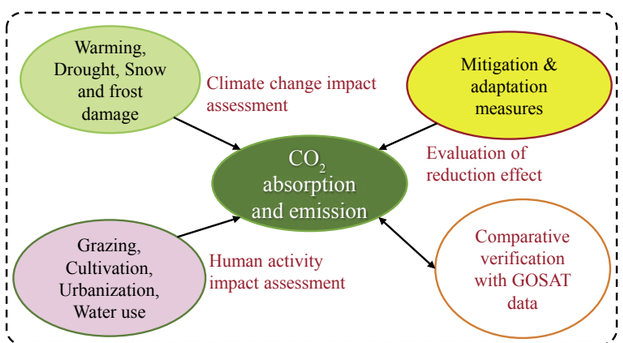


Monitoring CO_2 absorption and emission in pasture areas

We conduct ongoing on-site monitoring of CO_2 absorption and emission using greenhouse gas flux measurement systems established in pasture areas both near the city of Ulaanbaatar and far from urban areas.

Evaluation of the reduction effect by comparative verification with GOSAT products

We compare and verify the satellite data from GOSAT series products using field observation data and evaluate the reduction effect of low-carbon systems constructed in pasture areas.



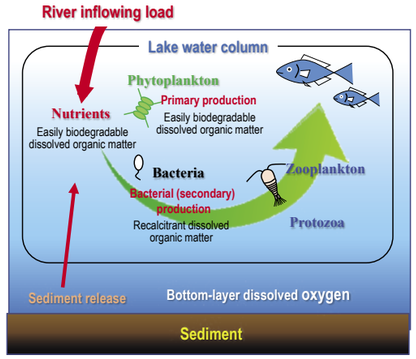
Contribute to the Joint Crediting Mechanism (JCM)

Lake Biwa Branch Office

The Lake Biwa Branch Office is a laboratory jointly managed by the Regional Environmental Conservation Division and the Biodiversity Division, and is located in the Lake Biwa Environmental Research Institute, a research facility belonging to Shiga Prefecture. The Branch Office conducts comprehensive research on water quality, bottom sediment, and the ecosystem, for the conservation and restoration of Lake Biwa, which is a great national asset in Japan.

Evaluation of the soundness of the water and bottom environments of Lake Biwa

In recent years, the inflow load entering Lake Biwa has been reduced, and the water quality in the lake and inflowing rivers is improving. On the other hand, new issues related to the ecosystem have arisen, such as a decrease in the number of native fish and shellfish and the overgrowth of large green algae. In addition, problems associated with the effects of climate change, such as hypoxia at the bottom of the lake, which is caused by the suspension of the full water overturn of the lake, have been confirmed. To deal with these issues and conserve, manage, and restore the environment of Lake Biwa, which is indispensable for building a sustainable society in Shiga Prefecture, we are conducting research to understand in detail the current status of both the water and bottom environments of Lake Biwa.



Elucidation of the material cycle in Lake Biwa

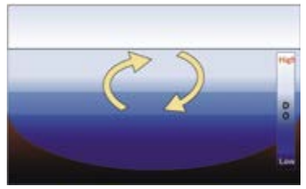
Exploration of a well-balanced material cycle for water quality and the ecosystem in lakes

Water-quality monitoring

Construction of a high-frequency monitoring platform that contributes to research on the water environment of Lake Biwa, such as monitoring of dissolved-oxygen dynamics

Full overturn of the lake

Numerical simulation analysis of an incomplete full-overturn mechanism of Lake Biwa, which is a major environmental issue

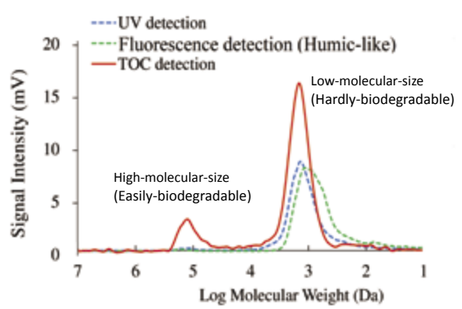


Measurement of the molecular size of dissolved organic matter (DOM)

DOM plays an important role in the organic-matter cycle of lakes and has different biogeochemical properties depending on its origin and formation process. In particular, the dynamics of easily degradable DOM available to living organisms is important when considering its impact on water quality and ecosystems. The bioavailability of DOM is closely related to its molecular size. The Lake Biwa Branch Office is analyzing the molecular size distribution of DOM and evaluating its effectiveness as a water environment soundness index.

Measurement of the molecular size distribution of dissolved organic matter (DOM)

Size exclusion chromatography system with a total organic carbon (TOC) detector



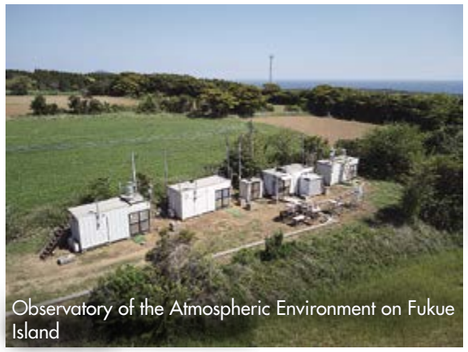
Quantitative analysis of high-molecular-size DOM

Quantitative measurement of TOC in high-molecular-size DOM, which is difficult to detect with existing detectors (e.g., UV and fluorescence)

Facilities

Long-term monitoring of the atmospheric environment in the East Asian region

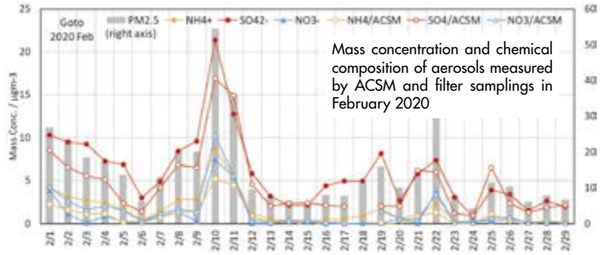
Atmospheric pollutants, including aerosols and gaseous components, are observed over the long term at Fukue Island in Nagasaki Prefecture to monitor their impact on the domestic atmosphere and to trace variation in their chemical compositions.


Observatory of the Atmospheric Environment on Fukue Island


Aerosol Chemical Speciation Monitor (ACSM)


Lidar


High-volume air sampler



- Measured items: mass concentration, chemical composition, vertical distribution of aerosols, concentrations of O_x and SO_2, and meteorological parameters
- Collaborators: Chiba Univ., JAMSTEC, AIST, Osaka Pref. Univ., and others

Vehicle test facility


Automated driver (robot) instead of a human driver

This facility can test fuel economy and the characteristics of emissions from low-emission vehicles such as pure electric vehicles and hybrid electric vehicles, as well as from internal combustion-engine vehicles using gasoline or diesel fuels under real-world conditions.
Published values for fuel economy are measured under specific conditions. Because few values have been measured under real-world conditions, vehicle performance has not yet been evaluated properly.
This facility has an exhaust-gas dispersion chamber for analyzing exhaust emitted to the atmosphere. It also has an equipment for analyzing in detail the characteristics of gaseous or particulate matter in exhaust.


Vehicle on a chassis dynamometer in the environment simulation room


Vehicle exhaust measurement system

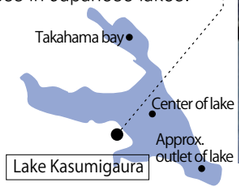

Confirmation of test results

Research station for preservation and enhancement of the water environment (Kasumigaura lakeside experiment facility)

Research Station for Preservation and Enhancement of the Water Environment locates at the lakeside of Lake Kasumigaura. The station spreading seven hectare area consists of the field experiment facilities for the lake eutrophication study.
On this research station, studies about pollution sources and their effects on aquatic environments are conducted. As for the baseline programs, this station belongs to various international monitoring networks such as GEMS/Water (Global Environment Monitoring System for freshwater), JaLTER (Japan Long-Term Ecological Research Network), and GBIF (Global Biodiversity Information Facility), contributing to the open data sources in Japanese lakes.


Kasumigaura lakeside experiment facility


The *NIES94*, a research vessel




The GEMS/Water[*1] trend monitoring program has 30 sites in Japan. We are managing the three sites in Lake Kasumigaura (Takahama-iri, Koshin, and Kojiri) with the Biodiversity Division of NIES.
[*1] The headquarter of GEMS/Water is located in Germany and operates data collection projects in many lakes and rivers.


Gas preparation line for the measurement of nitrate isotope ratios by mass spectrometry (hand-made by a researcher)


A bench-top device to measure photosynthesis rates


Stock room keeping water samples under 4 ℃

NIES photochemical smog chamber

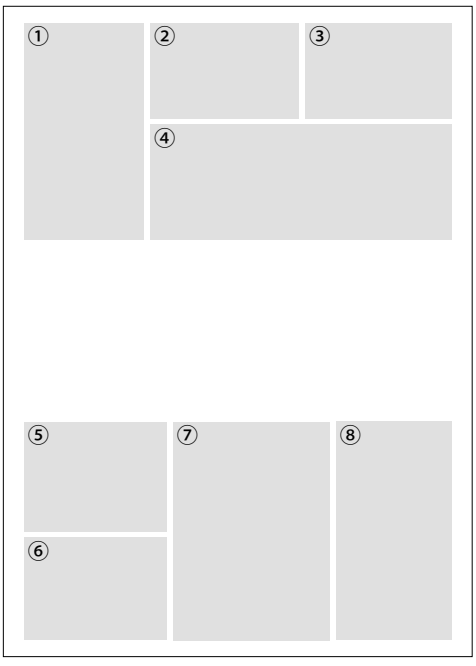

Smog chamber device

Air pollutants include not only those emitted directly into the atmosphere but also those produced by chemical reactions in the atmosphere, such as photochemical oxidants and secondary organic aerosols. Understanding chemical reactions in the atmosphere is essential for countermeasures against air pollutants. We are using the smog chamber to investigate the mechanisms of chemical reactions.


Multi-reflection mirror for infrared spectroscopy


Inside the solar simulator

Photographs on the front cover



①Regional Atmosphere Research Section “Lidar observation at NIES” p8-9

②Regional Atmospheric Modeling Section “Balloon projection of simulation results” p6-7

③Marine Environment Section “A scene from the seawater quality survey” p12-13

④Lake Biwa Branch Office “Lake Biwa Branch Office (installed in the building on the left) and the south basin of Lake Biwa (right)” p19

⑤Environment Management and Technology Section “Technical tour of a wastewater treatment system installed in Thailand” p17

⑥Principal Researcher (Wang) “Investigation of livestock water supply and groundwater changes in Mongolia” p18

⑦Soil Environment Section “A view of the soil survey” p14-15

⑧Lake and River Section “Measurement of lake photosynthetic activity by the fast repetition rate fluorometry (FRRF) method” p10-11

National Institute for Environmental Studies (NIES)

Regional Environment Conservation Division

16-2 Onogawa, Tsukuba-City, Ibaraki, 305-8506 Japan

https://www.nies.go.jp/chiiki/en/index_en.html

Feb.2022